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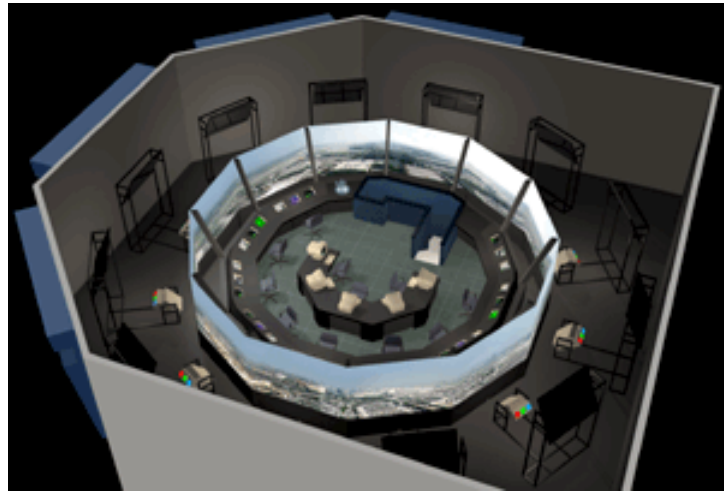
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1. Highlights of the NASA Ames Simulation Year

NASA's vision for the future is "to improve life here, to extend life to there, and to find life beyond." NASA Ames Research Center's three world class simulation facilities are doing just that, supporting NASA programs and the national air transportation system at large. The work done here is an essential and cost effective component of many forward-looking projects whose goals will lead us to that vision.

Ames is the home for FutureFlight Central, the Vertical Motion Simulator (VMS) and the Crew Vehicle Systems Research Facility (CVSRF) collectively known as the

Simulation Laboratories (SimLabs). Each specializes in areas of flight and flight management: air traffic control, the cockpit, and vehicle operation. All are designed to use humans as evaluators of new air traffic management and vehicle concepts.



FutureFlight Central Tower Cab Cutaway View

In fiscal year 2002 – 2003, the SimLab projects contributed to the national well being in the breadth and depth of work accomplished. Successful research and tests took place in the fields of aerospace transportation safety, air transportation system capacity, innovative information technology applications, and the development of advanced aerospace vehicle concepts.

The SimLabs also moved significantly closer to its long planned goal of gate-to-gate, real-time, human-in-the loop simulations, laying the foundation with a series of four interim tests. A notable application of this developing capability took place in February '03 with the Dallas/Fort Worth Perimeter Taxiway Demonstration in which pilots and DFW controllers jointly experienced a potential perimeter taxiway system in a realistic, operational setting.

Airport master plan improvements are very costly and require a lengthy approval process, so it is imperative to ensure that proposed changes fully deliver their advertised benefits. Therefore, Los Angeles World Airports, through its contractor HNTB, tested a center taxiway on the LAX south-side airfield at FutureFlight Central. New center taxiways on the south and north airfields are part of a master plan package of improvements that will cost up to an estimated \$9 billion.

One of modern life's great irritations is noise. To those living in and around an airport, it is no small matter nor is it a small matter for the airport. Although a priority for many years, multi-million dollar expenditures for noise mitigation continue.



To help alleviate airport noise, the CVSRF conducted a study of low-noise arrival procedures in conjunction with the Boeing Company, the FAA, and the Massachusetts Institute of Technology (MIT). Researchers studied the impact on controller workload of new procedures, emphasizing a Continuous Descent Approach (CDA) and developed a database for noise, emissions, aircraft performance, and inter-aircraft spacing for CDA arrival procedures during the final approach into the TRACON. Such a database will give researchers the data needed to design improved CDA controller tools and procedures, which will in turn help achieve the NASA's goal "to confine objectionable noise within airport boundaries."

*B-747 and Advanced Concepts Flight Simulators
housed in the CVSRF*

The International Space Station and its supply vehicle, the space shuttle orbiter, are the investments in the future. "From a full cost perspective, the [Space Shuttle Program] represents a \$3.8 billion annual investment (1). Since 1980, the VMS has supported the Space Shuttle Program, providing high fidelity, piloted simulations of landings and rollouts and serving as a critical training facility for the astronaut corps. Last year, astronauts participated in crew training and also evaluated a new Load Persistence Model, which is designed to predict tire failures. In the future, the VMS can play a critical role in the Return to Flight by providing enhanced training with landing and rollout procedures and "abort on ascent" scenarios.

The Simulation Laboratories *Year in Review* will be published in December and posted to the [SimLabs website](http://www.rand.org/scitech/stpi/NASA/nasaExecSum_final.pdf). More detailed descriptions of all the projects will be available there.

1. Alternate Trajectories: Options for Competitive Sourcing of the Space Shuttle Program:
http://www.rand.org/scitech/stpi/NASA/nasaExecSum_final.pdf

2. Kennedy Space Center Targets Training, Safety

NASA's space shuttle orbiters are valuable national assets. To safeguard these assets, operational procedures have been developed to ensure a safe launch and return to earth for the orbiters, their crews and payloads.

The Kennedy Space Center (KSC) Shuttle Landing Facility (SLF) is scheduled to open its new air traffic control tower in the spring. In September, KSC returned to FutureFlight Central (FFC) to simulate a training environment for the Shuttle Landing Facility. Previously, in 2002, KSC personnel used FutureFlight Central to validate their choice of a new tower location, tower height, and interior cab arrangement.

Orbiter landings at KSC have occurred approximately six to eight times a year. With landings of this frequency, it can be difficult to train and maintain proficiency in operational procedures. However, virtual training would enable tower controllers and support personnel to practice and refine procedures. For example, stopping and replaying elements in a simulation would give crews the opportunity to perfect their responses in a variety of different situations.

The September simulation concentrated on four different situations: day-to-day operations, convoy vehicle deployment, coordination of medical emergency response upon orbiter landing, and coordination of security breach response. Convoy and medical personnel were in attendance as observers and participants with FutureFlight, NASA Langley, and Moffett Federal Airfield Tower staff manning the FFC tower. To support the simulation, FutureFlight staff added additional air and ground vehicle models and augmented the 3-D database used in the 2002 tower siting study.



Over the two-day demonstration, FutureFlight successfully demonstrated the feasibility of virtual training for the Shuttle Landing Facility.

Convoy vehicle deployment scenario: vehicles are in place so that the crew can deplane

As Principal Investigator Dr. Dawn Elliott stated, "In this phase, we explored an alternate way of training. Actual opportunities for training with a full complement of vehicles are limited but a virtual environment would be available whenever it's needed."

With this simulation, KSC is taking steps to explore virtual training, a method that would make orbiter flights safer. Virtual training is a way to practice alternatives without risk to crew and orbiter. In fact, virtual training could explore alternative rescue scenarios safely as the [Columbia Accident Investigation Report \(CAIB\) R6.3-1](#) recommends in part: "Implement an expanded training program in which the Mission Management Team faces potential crew and vehicle safety contingencies beyond launch and ascent."

The Ames suite of simulators includes the orbiter cab, one of the motion-base cabs housed in the [Vertical Motion Simulator](#) (VMS). Astronauts train there approximately every nine months. As an added bonus during this simulation, FutureFlight and the VMS demonstrated their

connectivity through the use of the HLA "Bridging Technology." In the future, it might also be possible to explore and validate emergency procedures that would involve both the orbiter crew and the Shuttle Landing Facility personnel.



NASA Convoy Commander Dean Schaaf discussing the Demonstration with the NASA Advisory Council. Meeting four times a year, the Council directly advises the NASA Administrator about programs and issues.

3. Flying Gate to Gate: New Simulation Capability in '04

FutureFlight Central will gain new simulation partners in '04 through its further utilization of the High Level Architecture (HLA) technology. The Airspace Operations Lab (AOL), the Air Traffic Control Simulator, and the Advanced Concepts Flight Simulator (ACFS) will join with FutureFlight in a series of tests of gate-to-gate simulations.

Thanks to Adacel Inc., FutureFlight's simulation software provider, FutureFlight will acquire a key capability later this year when Adacel will implement new HLA features. Full functionality is expected with the milestone test in the summer of 2004.

Who are FutureFlight Central's new partners? The AOL can very realistically simulate en route or terminal radar approach control (TRACON) operations. In the Lab, eight controller positions are available which can be split as the research demands into any combination of TRACON/Center positions. Though not sufficient to study an entire FAA Center or TRACON facility, the AOL can study the transition of traffic between en route and TRACON airspace.



TRACON Control Room at the Airspace Operations Laboratory

The Air Traffic Control Simulator supports flight simulation research in the Crew Vehicle Systems Research Facility (CVSRF). Eight Center and TRACON positions are also available there. Ideally, if the AOL and the ATC Simulator were combined for a simulation, one facility would be a Center and one would be a TRACON.

ACFS, also housed in the CVSRF, is a flight simulator configured as a generic aircraft, capable of investigating flight concepts of the 21st century. A two-man crew flies the ACFS, which is configured as a 200-passenger capacity aircraft.

As in any partnership, getting everything to work together is challenging, particularly in the software domain. Many different components are being brought together utilizing a distributed architecture (HLA) with new tools for communications, and data collection and analysis.



Air Traffic Control Simulator in the Crew Vehicle Systems Research Facility

The HLA development and tests are conducted under the umbrella of the Virtual Airspace Simulation Technology-Real Time (VAST-RT) project, a cornerstone of the [Virtual Airspace Modeling and Simulation Project](#) (VAMS). One of the VAMS simulation goals is to: "Establish a simulation capability that will enable safe investigation of complex advanced air transportation concepts, and develop a deeper understanding of human performance interaction with it."

4. Why Human Factors

Human factors research is the study of human cognitive functioning, including how humans interact with new technologies. Unfortunately, human beings are sometimes inconsistent and unpredictable. They can forget or make errors. At Ames, research is aimed at working with human limitations to make air travel safer and more efficient.

Intensive human factors research early in the development cycle would have helped greatly with the creation and deployment of the Standard Terminal Automation Replacement System (STARS). STARS was designed to replace the aging Automated Radar Terminal System (ARTS) in use at FAA TRACONs across the nation.

Initially, the STARS contractor intended to use a “commercial off-the-shelf” (COTS) system, designed for use in Europe. However, they did not seek substantial input from U.S. air traffic controllers during development. Once controllers were introduced to the system, it became obvious that the COTS system would not be adequate. Some of the problems with the COTS system were the following:

1. The system was unable to adequately handle the large volume of US traffic.
2. Controllers objected to the new user interface, which required more time and mental effort. In particular, controllers were opposed to the use of a trackball and keyboard entries to replace the highly familiar knobs used for basic functions. It is far easier to simply twist a knob, which can be done without shifting the scan from the radar scope.
3. Controllers needed a safer design that mimicked the old interface because in high stress situations they tend to revert to the familiar.

The contractor had to redesign the interface, resulting in increases from the original \$940 million to a projected cost of \$1.4 billion or more and substantial delays in deployment.

That’s why it’s so useful to try new technologies, procedures or airport configurations using air traffic controllers or pilots as evaluators in a realistic and safe virtual environment before implementation. In the three and one-half years that FutureFlight has been in operation, our customers have taken advantage of our capabilities in a variety of ways.

Dallas/Fort Worth International Airport (DFW) had studied perimeter taxiways for years before coming to FutureFlight in February, ‘03 to test the perimeter taxiway concept with pilots and air traffic controllers together. Virtual reality proved the ideal venue to live the experience. The [report](#) of that experience is available on our website.

In 2001 – 02, DFW controllers first evaluated the Surface Management System (SMS), a new decision support tool developed at Ames Research Center and now in site testing at Memphis Airport. Stephen Atkins, NASA Project Lead for SMS, explained it thus:

"FutureFlight Central allows the eventual users to experience SMS in a realistic environment. It's not until controllers try using a DST [decision support tool] that they can provide the feedback needed to design a usable and useful product.

We learned a tremendous amount, for example, about how controllers assign departures to runways, sequence departures, and select taxi routes, and how

SMS can better help tower controllers perform their tasks."



Controllers at the DFW East Ground 1 and 2 and at East Local 1 manage east side traffic with the Surface Management System displays visible at the Traffic Management Coordinator's station.

Read about more [FutureFlight projects](#) on our website.

Descriptions of human factors work at Ames can found at: <http://olias.arc.nasa.gov>.

5. LAX Center Taxiway Study Now Available Online

On October 13, 2003, Los Angeles World Airports (LAWA) posted the following press release to its website: [NASA Simulation Shows New Taxiways May Increase Safety at LAX](#) . The project report of this simulation is available on our website at http://ffc.arc.nasa.gov/our_projects/lax_phase3.html#lax_phase3_report.

6. Upcoming Events & Conferences

NASA FutureFlight Central will be participating in the following event:

- ▶ ATCA 48th Annual Meeting, International Technical Program and Exhibits, October 26 – 30, 2003, Marriott Wardman Park Hotel, Washington, DC
- ▶ AAAE's 13th Annual Airport Emergency Response School, January 18 - 23, 2004, Tucson, Arizona. FutureFlight's air traffic control analyst Rob Voss will give a presentation about the latest simulation technology.

The NASA Ames Simulation Laboratories will be participating in the following event:

- ▶ Interservice/Industry Training, Simulation & Education Conference (IITSEC), December 14, 2003, Orlando, Florida. The SimLabs Booth is #1842 and #1844. For more information, see <http://www.iitsec.org>

7. Thinking of Doing Business with FutureFlight Central?

Contact:

Nancy Dorigi, FutureFlight Central Manager,
Nancy.S.Dorigi@nasa.gov, 650.604.3258

Ken Christensen, FutureFlight Central Business Development Manager,
Kenneth.L.Christensen@nasa.gov, 650.604.0188

for more information and to explore what we can do for your needs.

The Team at NASA FutureFlight Central <http://ffc.arc.nasa.gov>

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